TIME FACTOR OF CORE EMOTIONS DERIVED FROM DESIGN MATERIALS: TOWARDS A DEEPER UNDERSTANDING OF PRODUCT EXPERIENCE

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ABSTRACT

Impressions and emotions affect both the selection of a product and its long-term use. We need to investigate the origins of emotions from designed products in order to create better product designs. This study focuses on the time factor of emotions, particularly on the impression formation of product design materials. We conducted an experiment to observe how participants experienced a set of product design materials. We identified and compared the core emotions formed early in the process and the accompanying experiences from the entire session. The results suggest that the provided designed products elicit core emotions that are usually formed on first contact with the materials, are strongly associated with basic emotions, and define what people think about the use of the products. These findings are important in helping to improve product design and the design of products that evoke emotional attachments.

Keywords: user experience with materials, product design materials, emotions in time.

INTRODUCTION

Why people are attracted to certain products and which associations and emotions these products evoke are questions of interest in research on product experience (Norman, 2004; Hekkert and Schifferstein, 2008). Users’ emotions are instrumental to an overall experience of the products themselves, and the elicited emotions shape the users’ plans and intentions about using the products (Carlson, 1997). Moreover, impressions and emotions contribute to attachments and opinions about designed products. These emotions affect both the selections of the products and their long-term use (Karana, 2009).

In order to create a long-lasting positive product experience, designers need to consider the different modes of user-product interactions at different stages of a product’s usage (Fenko et al., 2008). This means that the point of origination of emotions formed from interaction with the designed products have to be investigated in order to create product designs that evoke a positive experience.

INVESTIGATING IMPRESSIONS AND EMOTIONS

Emotions derived from product materials are difficult to isolate from the overall user experience of designed products. However, these emotions linked to the product materials contribute to the attachments and/or opinions about the products themselves (e.g. quality, make, use, and durability) and thus, the entire image of the products. Moreover, these emotions affect both the choices and time-scale of product use (Hekkert and Schifferstein, 2008; Sonneveld and Schifferstein, 2008; Karana, 2009).

Little is known about how these emotions are formed in users’ encounters with product materials, because studies on product experiences usually focus on the products as a whole and on the result of product experience. Thus, we need to investigate the origins of emotions formed during users’ initial encounters with product materials (van Rompay et al., 2005) and provide methods of analyzing emotions at that point in time.

How are human emotions formed in short-term when experiencing design materials? Do first impressions influence human emotions at the end of the short-term experience of design materials? To answer these questions, this study focuses on the time...
factor of users’ emotions in the micro-dimensions of these experiences, that is the first moments of the users’ experiences with materials. We pay particular attention to the impression formation of designed products’ materials. We consider this dimension of interaction to be important for the user to develop sustainable and product experiences of attachment. Thus, this study investigates the initial time when core emotions are formed in the users’ experiences with product materials.

People ascribe many interpretative impressions and meanings to designed artefacts (Karana, 2009). The interpretative impressions and meanings include emotions toward the products. Recently, studies have focused on understanding the actual impressions behind superficial interpretative impressions and meanings (Fasiha et al., 2010). A true impression that is formed after using a product serves to evoke deeper impressions (core emotions). These true impressions differ from the superficial interpretative impressions and meanings because the user learns about the product and cultivates a deeper understanding of it. The true deeper impressions are described as an image schema (Lakoff and Johnson, 1999) in connection with the creation of meaning. Such image schemas refer to the creation of basic descriptions such as positive-negative or in-out. On the basis of such associations, users establish numerous extremely rich metaphorical concepts (including impressions, meanings, and emotions). More recently, such deeper impressions have been found to be responsible for users’ perceptions of natural and artificial product materials (Nagai and Georgiev, 2011).

For the purposes of this study, we define core emotions as deeper associative layers of users’ expressed impressions. As such, the core emotions underpin the explicit impressions.

ISSUES AND FRAMEWORK OF STUDY

The issues related to the design of products are how emotions are formed and if these emotions depend on initial experience of the product material. To understand these issues, we propose a framework that will allow us to investigate the formation of the emotions elicited from design materials. This framework is shown in Figure 1. We propose a viewpoint to product experiences as an underlying layer of core emotions that are evolved from the initial core emotions on first experience with the product material. These initial core emotions develop into the formed core emotions based on the whole experience. Detecting, analyzing, and comparing the core emotions at these two stages would allow us to gain insights into the aforementioned issues. We also consider how these issues affect the formation of an image of the material and further design image.

Figure 1. Framework of study

OBJECTIVE

The objective of this study is to investigate the formation of core human emotions in time (time factor in short-term) when experiencing design materials. To achieve this objective, a method using associative concept networks analysis methodology comprised the following (Figure 2):

- An experiment during which participants were exposed to a series of design materials. Verbalizations describing their experiences were recorded, and a protocol analysis of the human verbalizations was performed.
An innovative associative concept networks analysis was performed to identify the core human emotions based on the recorded verbalizations. This analysis method uses concept pair detection based on a concept dictionary database and graph analysis approach. For this study, the steps of concept networks analysis were as follows:

1. The verbalized impressions of all participants were treated as associated from certain words;

2. Associative word pairs (associative word and verbalized word) were detected with assistance of a database tool (associative concept dictionary);

3. Concept networks were then created and core emotions from the constructed concept networks were identified from each session (case) (an approach developed on the basis of the work of Zhou et al., (2009)).

Figure 2. Method of study.
• Quantitative analysis: comparison of core emotions formed during the first few seconds of the initial product experience and from the entire session (whole experience).

EXPERIMENTAL METHODOLOGY
The methodology of user interactions consisted of freely expressed user impressions upon touch, look and feel interaction with each of seven material samples. The experiment was conducted in a quiet laboratory room with pale colours without any unnecessary for the experiment interior objects or materials.

PROCEDURE
Eleven participants (six males and five females) took part in the study. Their experiences were observed via verbalized impressions of seven sample materials commonly found in daily living. The mean age of the participants was 29 years and the standard deviation was 7.0 years. All participants were either graduate students or university staff members. The length of the interactions (length of experiment period) depended on users’ verbalised impressions and was between 13 and 48 minutes for all seven samples. The verbalized protocol was recorded for further analysis.

SAMPLES
We included materials that are widely found in products (i.e. products that are frequently experienced): metal plate, plastic board, and wood plate. We also included materials that are found less frequently in products: cork panel, glass window, rubber matt, and metal net. The size of each material sample was approximately 200 by 100 mm, allowing participants to freely experience each sample.

ANALYSIS AND RESULTS
The protocols of all human verbalizations were transcribed, and each word (verbs, nouns, and adjectives) were employed in the next analysis with concept networks. As a result, the core human emotions were identified from the graph visualizations of these networks. The identified core emotions from networks of the first experience (the core emotions formed early in the process—based on the first verbalization only) and of the full experiences (until the end of the sessions—the experiences of the entire session) with the seven design materials were compared.

Figure 3 shows the visualized concept networks of core emotions. We used a common visualization software tool—Pajek (Pajek 2.03, 2011). The concept networks of initial core emotions are shown on the left side of the figure and those of formed core emotions are shown on the right as per material samples. One upscale concept network example is shown.

To detect core emotions elicited on first contact, we considered only the first impression verbalizations. The aforementioned method was employed together with an associative word pair database (associative concept dictionary)—the University of South Florida free association, rhyme, and word fragment norms database (Nelson et al., 2004a; 2004b). This database is regarded as the most extensive concept dictionary in the English language. The tool was constructed in a large-scale association experiment and considers nouns, adjectives, and verbs in associative pairs (totalling more than 72,000 word-pairs). Such extensive coverage is suitable for word-association pair searches.

Highly weighted associative words were considered core emotions. The weighting limit was set approximately at the upper half of word groups, based on the number of connections initiated. Table 1 shows the core emotions from the materials elicited on first contact.

We conducted the same analysis with all verbalization from the full experiences. Table 2 shows the core emotions elicited on first contact and kept throughout the session.

QUANTITATIVE ANALYSIS
The identified core emotions from the first experience and the whole experience were compared in the next quantitative analysis step. Table 3 shows the proportion of core emotional words kept throughout the experience; 100 percent means that all the initial core emotions were also present in the formed core emotions.
Figure 3. Concept networks of core emotions
Table 1. Core emotions elicited on first contact

<table>
<thead>
<tr>
<th>Product Material</th>
<th>List of core emotional words elicited on first contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cork Panel</td>
<td>bottle, plug, stopper, rug, clothes, gentle, spring</td>
</tr>
<tr>
<td>Wood Plate</td>
<td>stage, dense, wild, gentle, hectic, mild, smooth, uneasy, violent, bedroom, elevator, kitchen, mat, opening, wall, ceiling, delicate</td>
</tr>
<tr>
<td>Metal Net</td>
<td>display, glass, view, bay, bedroom, blind, blinds, cleaner, clear, curtain, curtains, defrost, door, drapes, frame, glare, ledge, open, pane, rear, screen, shade, shutter, shield, shingle, shop, shutter, silt, storm, vent, wall, windshield, wipe, computer, film, lint, movie, patio, television, theatre</td>
</tr>
<tr>
<td>Metal Plate</td>
<td>steel, marble, shoulder, defrost, rigid, brisk, extreme, metal, severe</td>
</tr>
<tr>
<td>Plastic Board</td>
<td>admire, awe, care, brand, clothes, designer, fashion, grace, body, bold, graceful, Hawaii, quilt, harsh, soft, gentle, heater, mild, spring, bran, iron, steel, stiff</td>
</tr>
<tr>
<td>Rubber Matt</td>
<td>lubricate, suede, crunchy, felt, flat, harsh, prickly, rigid, satin, sharp, silk, skin, soothe, subtlety, velvet, bounce, foam, leather</td>
</tr>
<tr>
<td>Glass Window</td>
<td>marble, pool, basement, cellar, crisp, dark, darkness, dead, defrost, detach, extreme, frozen, handkerchief, hate, metal, rigid, severe, shake, shutter, steel, stone, uncomfortable, bench, wood, coffee, wipe</td>
</tr>
</tbody>
</table>

Table 2. Core emotions elicited on first contact and kept throughout the session

<table>
<thead>
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<th>Product Material</th>
<th>List of core emotions elicited on first contact and kept throughout the session</th>
</tr>
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<tbody>
<tr>
<td>Cork Panel</td>
<td>bottle, plug, stopper, rug, gentle, spring</td>
</tr>
<tr>
<td>Wood Plate</td>
<td>stage, dense, gentle, mild, bedroom, opening, ceiling, delicate</td>
</tr>
<tr>
<td>Metal Net</td>
<td>display, glass, view, bay, bedroom, blind, blinds, cleaner, clear, curtain, curtains, defrost, door, drapes, frame, glare, ledge, open, pane, rear, screen, shade, shutter, shield, shingle, shop, shutter, silt, storm, vent, wall, windshield, wipe, computer, film, lint, movie, patio, television, theatre</td>
</tr>
<tr>
<td>Metal Plate</td>
<td>steel, marble, shoulder, defrost, rigid, extreme, metal, severe</td>
</tr>
<tr>
<td>Plastic Board</td>
<td>grace, bold, harsh, soft, gentle, mild, iron, steel, stiff</td>
</tr>
<tr>
<td>Rubber Matt</td>
<td>lubricate, suede, crunchy, felt, flat, harsh, prickly, rigid, satin, sharp, silk, skin, soothe, subtlety, velvet, foam, leather</td>
</tr>
<tr>
<td>Glass Window</td>
<td>marble, pool, basement, cellar, crisp, dark, darkness, dead, defrost, detach, extreme, frozen, handkerchief, hate, metal, rigid, severe, shake, shutter, steel, stone, uncomfortable, bench, wood, coffee, wipe</td>
</tr>
</tbody>
</table>

Table 3. Proportion of core emotional words kept throughout the experience

<table>
<thead>
<tr>
<th>Product Material</th>
<th>Proportion of core emotional words kept throughout the experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cork Panel</td>
<td>86%</td>
</tr>
<tr>
<td>Wood Plate</td>
<td>47%</td>
</tr>
<tr>
<td>Metal Net</td>
<td>100%</td>
</tr>
<tr>
<td>Metal Plate</td>
<td>89%</td>
</tr>
<tr>
<td>Plastic Board</td>
<td>39%</td>
</tr>
<tr>
<td>Rubber Matt</td>
<td>94%</td>
</tr>
<tr>
<td>Glass Window</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4 shows the proportion of core emotional words elicited on first contact, the proportion of core emotional words that appeared after the first experience and elicited from the entire session. It quantitatively indicates the development of the core emotions from the beginning of the experience to the end of the session.

Figure 4 shows a schematic of the development of the core emotions. On the basis of the quantitative analysis of the core emotions, (a) the number of initial core emotions, (b) number of ‘dropped’ core emotions, (c) number of ‘kept’ core emotions, and (d) number of formed core emotions are represented by circles corresponding in size to the actual numbers. This is a summary of the quantitative analysis of the core emotions, based on data from Tables 3 and 4.

We can see that different patterns can be identified, with a general observation that most of the initially evoked core emotions are kept throughout the product material experience.
DISCUSSION

The findings show that the provided materials elicit emotions that are time dependent; however, the initial core emotions are important. Five of these materials (metal plate, cork panel, glass window, rubber matt, and metal net) resulted in the formation of persistent core emotions upon first contact with the materials, that is the core emotions expressed in the initial moments of the experience were maintained and were responsible for a portion of the final core emotions (cf. Tables 2 and 3). In contrast, in the case of the other two material samples (wood plate, plastic board), the core emotions formed from experience with the materials were different between first contact and at the end of the session. The implications from the further discussed qualitative analysis are important for product design.

THE CONSISTENCY OF CORE EMOTIONS

Two particular samples (plastic board and wood plate), dropped a significant part of the core
emotions (Figure 5). These findings are particularly interesting because the plastic board sample lost core emotions such as ‘admire’, ‘care’, and ‘graceful’ and kept core emotions such as ‘harsh’. This shows that the core impressions evolved initially from positive to mostly negative emotions. Likewise, but in the opposite direction, another sample, wood plate, dropped core emotions such as ‘wild’, ‘uneasy’, and ‘violent’ and kept ‘gentle’ and ‘delicate’. In this instance, the core emotions evolved from an interpretation of negative emotions to mostly positive emotions. Why some core emotions regarding two materials evolve can be explained with frequency of their experience.

Why some core emotions regarding two materials evolve can be explained with frequency of their experience.

**Figure 5. The consistency of core emotions**

**EVOLVED VS. KEPT CORE EMOTIONS**

Two samples have evolved their core emotions distinctly in opposite directions—the aforementioned plastic board and wood plate (cf. Table 3 and Figure 4). One possible reason may be due to their wide application in many designed products. Users may take some time to form (identify) which core emotions (positive or negative) to evoke from these materials, and this may be connected with revisiting previous product material experiences.

On the other hand, the metal net and glass window samples evoked core emotions on first experience, which are kept and grown during the experience of these materials. A possible reason can be due to distinct types of products found based on the sample material (e.g. window net). Thus, in these cases, users form core emotions very quickly and stay on these emotions for the rest of the experience. This is probably related to previous experiences with particular types of products.

**GROWN VS. EVOLVED CORE EMOTIONS**

The material samples with core emotions growing in number (cork panel, metal plate, and rubber matt) as the experience continued show that certain core emotions have an expansive nature during the product experience. The users probably ‘built up’ the core emotions from these materials and this is evident from their distinct characteristics (e.g. the tactually distinctive interaction with samples such as cork panel and rubber matt). This is different from the evolved type of user experience (plastic board and wood plate). The evolved type develops the experience in either a positive or negative direction during the process.

**CONTRIBUTIONS AND LIMITATIONS**

Our findings clarified the importance of time for the development of emotions and product experiences. This time factor is a new dimension in understanding users’ emotions derived from design materials. The findings suggest that an important part of core emotions is often formed at the first moment of an experience and that these core emotions are potentially responsible for the full emotional image of materials.

We can ascribe that the time factor of core emotions derived from design materials depends on:

- Identification and revisit of core emotions (positive or negative)
- Utility associations of the material
- Tactually distinctive interaction with the material

The importance of our findings for improvement of product design can be outlined as follows:

- A deeper understanding of the product experience. Knowing how core human emotions in experiences with design materials are formed will influence the designing and marketing of products that can evoke emotional attachments;
- Improving selection of the material by the product designer; and
- A strong methodological approach to identify and analyze core emotions in the product experience.
The analysis we employed successfully makes core emotions tangible on the basis of various verbal expressions of human emotions and not merely the adjective descriptors. However, this study is limited by the number of material samples used and the sample size of participants. For future research, a wider range of materials and a larger number of subjects need to be assessed, to substantiate the findings from this study.

**FUTURE WORK**

Findings from this research of core emotions in users’ product experience point toward two major directions:

- A extensive qualitative analysis of the core emotions; and
- An investigation of the core emotions in a macro-dimension of product experience—towards an understanding of emotional attachments developed with long-term product experience.

Future research should investigate the time factor on a larger scale to determine how core emotions are developed during extended product experiences. According to the findings about consistency of core emotions, the evolvement of core impressions (from positive to negative emotions or opposite) may be connected with human preferences on first experience, which may differ from preferences at the end of short-time experience. This topic should be in the focus of future research on potentials for designing desirable products.

**CONCLUSIONS**

This paper focused on the time factor of emotions, specifically on impression formation of materials used in designed products. We conducted a study to observe how participants experienced a set of basic product design materials. We identified and compared the core emotions formed early in the process of user experience with the materials as well as the experiences from the entire session. The results indicated that elicited core emotions formed on first contact are kept throughout the experience with the materials. The identified core emotions are shown to be strongly associated with basic impressions and they define what people think about the use of the product, especially regarding identification and revisit of emotions; utility associations of the material; and tactually distinctive interaction with material. These findings are important in improving product design and designing products that can evoke emotional attachments. Moreover, it is a step towards designing sustainable product use.

**REFERENCES**


